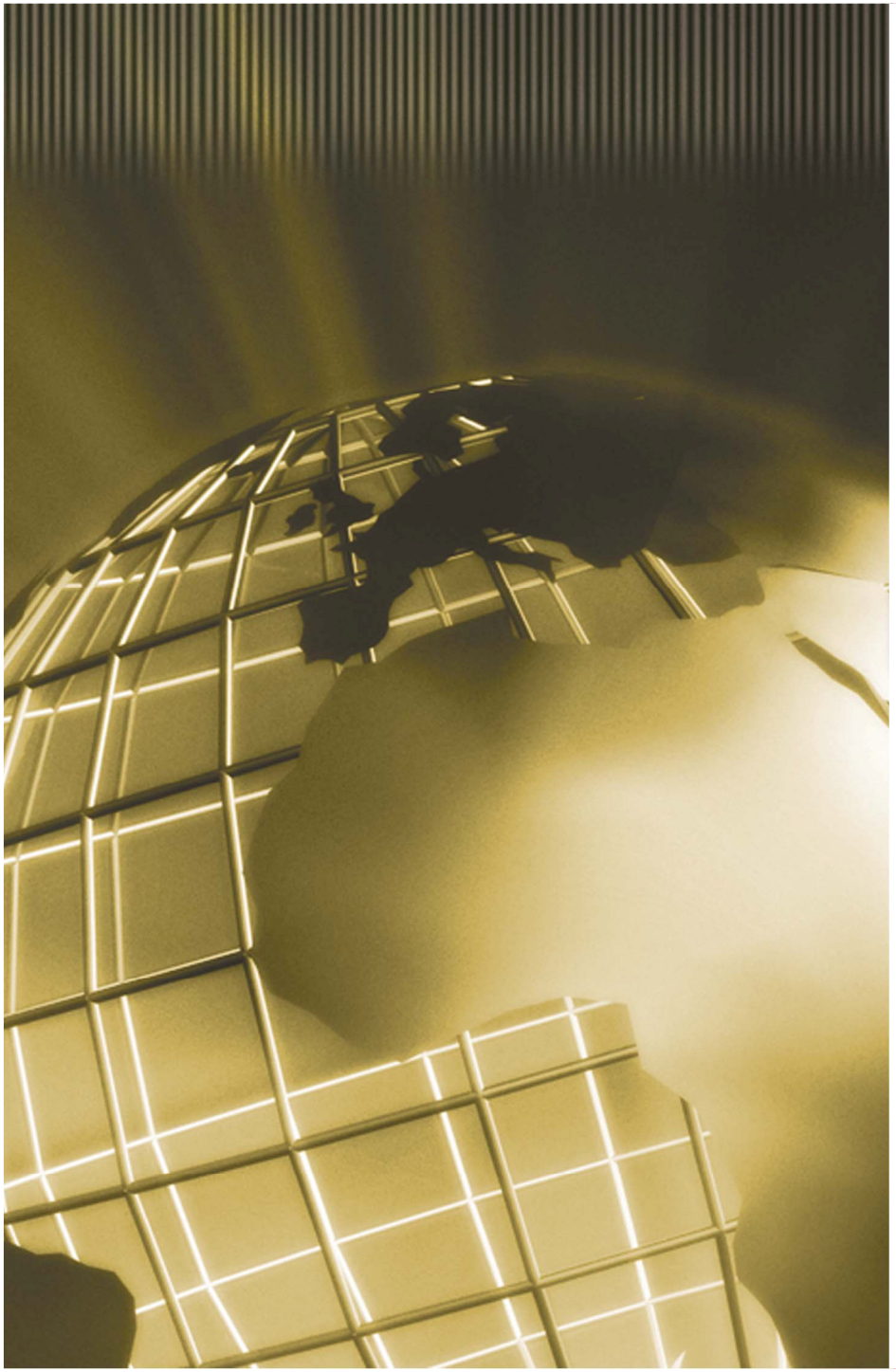

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Executive Summary:

Feasibility Study for the Terrestrial segment of the NEPAD ICT Broadband Infrastructure Network for Eastern and Southern Africa

Issued by:
Africa Analysis Team (Pty) Ltd
Andre Wills, +27 12 664 7914

Agenda

Confidential Information collected for the Feasibility Study for the Terrestrial segment of the NEPAD ICT Broadband Infrastructure Network for Eastern and Southern Africa Project.

Confidential Information:

- This report is presented to the NEPAD e-Africa Commission and presents the project findings for the Feasibility Study for the Terrestrial segment of the NEPAD ICT Broadband Infrastructure Network for Eastern and Southern Africa.
- Information used in this project was provided by network operators under a Non-Disclosure Agreement and therefore there exist restrictions on the disclosure of information to a 3rd party. These are:
  - The network operator's network topology, network roll-out and development strategies remain confidential and may not be provided to any 3rd party
  - This restriction applies to all the project deliverables that include (but not restricted to): written documents, Excel models, databases and maps of network infrastructure

1 Executive Summary

Background and Project Objectives: NEPAD commissioned a feasibility study of a deployment of a commercial optical fibre network in the Eastern and Southern African region that would provide inter-country connectivity.

Project Objectives

- An ICT Broadband Infrastructure Network, consisting of a terrestrial segment and a submarine segment, covering 23 countries in Eastern and Southern Africa, is to be developed for the region.
- A policy and regulatory framework within which the network is to be developed has been agreed and is detailed in the "Protocol on Policy and Regulatory Framework for the NEPAD ICT Broadband Infrastructure Network for Eastern and Southern Africa".
- A Special Purpose Vehicle (SPV) is to be established that will own, develop, operate, and maintain the terrestrial segment of the network and shall operate within the provisions of the Kigali Protocol.
- In order to attract potential investors to take part in the SPV, it is necessary that the technical and commercial viability of the network be ascertained.

The scope of work for this study includes:

- A comprehensive study of the complete terrestrial network segment of the NEPAD network.
- A study of a minimum terrestrial network to interconnect the 12 countries that have signed the Kigali Protocol. The inputs to this study to be derived from the activities undertaken for the comprehensive study.

Network design options considered:

- From the objectives and scope of work, four network design options needed to be considered:
  - All countries / All build network design
  - All countries / Maximum lease design
  - Kigali Protocol countries / All build network design
  - Kigali Protocol countries / Maximum lease design

1 Executive Summary

Project Deliverables: The project deliverables consisted of four deliverables: (1) Project report, (2) Database of operator networks, (3) Network design models and (4) Regional telecommunication infrastructure maps.

Deliverable 1: Project Report

- A comprehensive report detailing the findings of the project.
- The report presents an analysis of each country, the traffic forecasts for each country, the network design and costing and recommendations regarding network roll-out options.
- Two reports, Part 1 – NEPAD Executive Report Network Design and Part 2 – NEPAD Executive Report Country Profiles, are provided.

Deliverable 3: Traffic Forecast and Network Design

- The four network design options along with the traffic forecasts (2009 to 2024) are provided in four separate Excel models.
- These models contain the detailed traffic forecast per country, the network design and costing.

Deliverable 2: Database of Operator Networks

- The operator network information was captured in a GIS program and Dynamic Maps, and provided as part of the project deliverables.
- The database shows all optical fibre and microwave network infrastructure, both operational, currently being deployed and planned. This information is shown by network operator.
- Network infrastructure provided by utility providers is shown as well.
- The database of operator infrastructure is provided to the NEPAD project team under the Non-Disclosure Agreements signed with various network operators that restricts the release of this information to any third party outside of Africa Analysis and the NEPAD project team.

2 Introduction

Project Scope of Work: The objective is to ascertain the technical and commercial viability of a NEPAD terrestrial telecoms network in Eastern and Southern Africa.

Within the scope of work, the study specifically focussed on

- Identification of gaps in the existing optical fibre infrastructure, existing along the routes of the NEPAD network. Identification of plans to close such gaps.
- Determining the cost of leasing optical fibre cable capacity from the existing operators / cable owners and building of new optical fibre cable infrastructure where necessary.
- Estimating the cost of operating a Regional Operations Centre and data centre from which the entire network would be monitored, managed and controlled.
- Estimating the costs of establishing and equipping nodal points in each country.
- Undertake a detailed study of traffic flow through the network.
- Propose an optimum network in terms of network economics, configuration and costs.

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Key Stakeholder Interviews: Information was sourced through visits to 13 countries. Additional information was sourced through telephonic interviews and/or through secondary research (this included the purchase of information).

Country visits to key stakeholders

- Country visits were undertaken to 13 countries. During each country visit the following stakeholders were interviewed:
  - National regulatory authority and government departments
  - Fixed line operators
  - Mobile operators
  - Utility providers
  - Internet Service Providers (ISPs)
- Interviews were conducted in both English and where required in Portuguese and French.
- The visiting team used prepared network diagrams and semi-structured questionnaires to guide the discussion with the various network operators regarding their infrastructure.
- In total the team conducted 120 personal and telephonic interviews across the 23 countries.

Telephonic interviews with network operators

- Telephonic interviews were held with network operators from some of the countries that were not visited.
- Furthermore, telephonic interviews were also used to follow-up on in-country visits.

Secondary research on network operators

- Secondary research was undertaken on network operators.

Purchase of information: Traffic information and operator network topology information were purchased prior to the country visits.

Hamilton Research Ltd ■ Operator national network topologies was purchased from Hamilton research. ■ Where possible this information was augmented from information provided by network operators through the in-country interviews.	**TeleGeography traffic information** ■ Africa Analysis purchased international voice traffic data from TeleGeography. ■ Where possible this information was augmented from information provided by network operators through the in-country interviews. ■ This information was used to establish the inbound and outbound voice traffic profiles per country.
IMF Economic Data ■ Economic information was sourced from the International Monetary Fund (IMF) database.	**Secondary research** ■ Secondary research was undertaken to compliment the purchased information. This involved the review of reports issued by the various network operators and utilities (for example electricity, water, rail). ■ Secondary research was also used to compliment the information sourced through in-country visits and telephonic interviews.

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Countries included: A total of 23 countries were part of the study. Africa Analysis visited operators and utility companies in 13 countries. The balance of the countries were addressed via secondary research and telephonic discussions with stakeholders.

Countries in this study

- Angola
- Botswana (KP)
- Burundi
- Djibouti
- DRC (KP)
- Eritrea
- Ethiopia
- Kenya
- Lesotho (KP)
- Madagascar (KP)
- Mauritius (KP)
- Malawi (KP)
- Mozambique
- Namibia
- Rwanda (KP)
- Somalia
- South Africa (KP)
- Sudan
- Swaziland
- Tanzania (KP)
- Uganda (KP)
- Zambia (KP)
- Zimbabwe (KP)

KP refers to the 12 Kigali Protocol countries that were included in the Kigali Protocol design.

Countries visited

- Angola
- Botswana
- DRC
- Kenya
- Malawi
- Mozambique
- Namibia
- Rwanda
- South Africa
- Tanzania
- Uganda
- Zambia
- Zimbabwe

1 Executive Summary

Integrated Design and Costing Model: An integrated traffic forecast, network design, network optimisation and cost model was developed to undertake the network designs for the various network scenarios considered.

Comprehensive review of current telecoms environment, per country

- Comprehensive desk research and in-country visits
- Operator landscape
- Operator optical fibre infrastructure (existing and planned)
- Alternative optical fibre utility infrastructure (existing and planned)
- Regulatory environment

Detailed analysis of traffic (voice and data, fixed and mobile, consumer and business)

- Economic drivers
- Technology lifecycle
- Analysis of voice and data from 2000 to 2008 (historical) and 2009 to 2024 (projection)
- Built an international traffic model for the SPV
- Designed various network options

Network designs

- Four network options were designed and costed

Basis for network design costing

- Realistic routing
- Vendor equipment costing
- Operator costing
- Network Operator Centre (NOC) and Country Node costing

Development of integrated traffic, network design and costing model included the following

- Economic forecasts, technology forecasts and traffic forecasts for the period 2009-2024
- Optimal routing based on least costs
- Optimised network design
- Redundancy options
- Full capex and network associated opex costing derivation 2009-2024

1 Executive Summary

Network Design and Costing: The four network designs considered are shown here.

Network Design 1: Kigali Protocol Countries (12 countries, 14 country nodes), maximum lease ■ The optimal network needed to carry traffic between the 12 Kigali Protocol countries: ➢ Lease undersea capacity where available ➢ The amount of leasable fibre is maximised on terrestrial routes ➢ Build only the capacity required to complete the network	**Network Design 2: Kigali Protocol Countries – Full build for all necessary links (All Build)** ■ The optimal network needed to carry traffic between the 12 Kigali Protocol countries: ➢ Lease undersea capacity where available ➢ Build all the capacity required to complete the network
Network Design 3: All Countries (23 countries, 25 country nodes), maximum lease The optimal network needed to carry traffic between all 23 countries: ➢ Lease undersea capacity where available ➢ The amount of leasable fibre is maximised on terrestrial routes ➢ Build only the capacity required to complete the network	**Network Design 4: All Countries – Full build for all necessary links (All Build)** ■The optimal network needed to carry traffic between all 23 countries: ➢ Lease undersea capacity where available ➢ Build all the capacity required to complete the network

1 Executive Summary

Network Design and Costing: Four network design options have been considered over a period of 15 years.

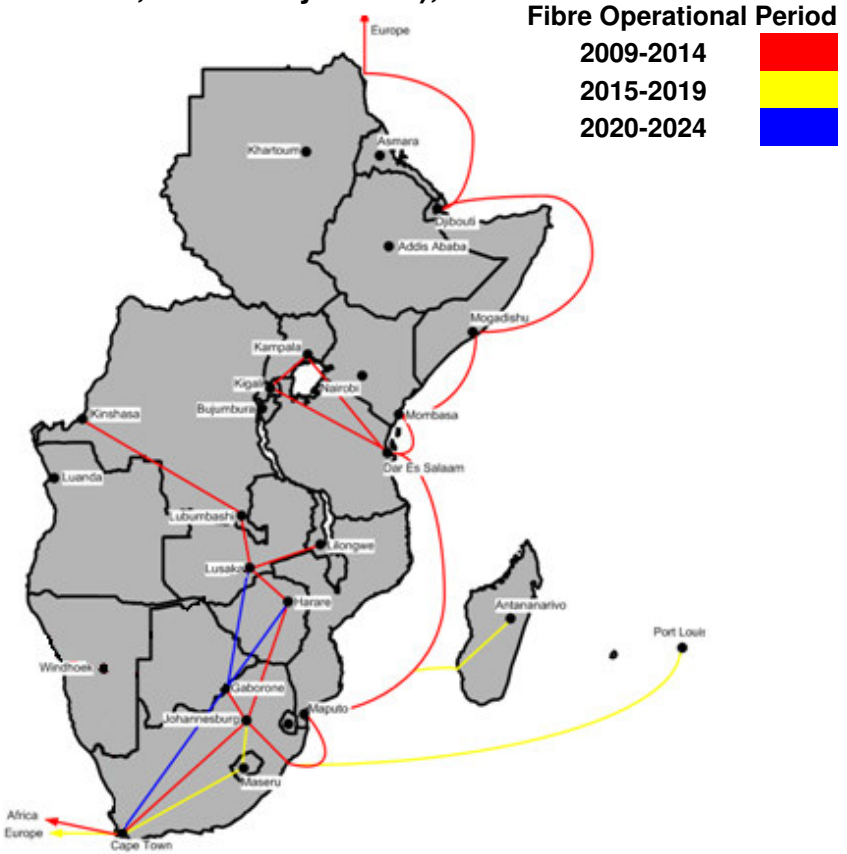
- Network Design provides:
  - Illustrative Routes and their Capacities, based on Leased dark fibre (terrestrial and undersea) and New Build fibre. In all cases the optical equipment is assumed to be provided new and owned by the SPV (regardless of whether the fibre is leased or owned) i.e. all equipment required to "light" the fibres has been included in all cases
  - Optimised timing of route and associated capex and opex, based on the minimum route capacity selected
  - Four Options have been considered as a Base Case where both the number of Countries included is varied, and the amount of Capacity leased is varied as follows :
    - Kigali Protocol Countries and Maximized Capacity Lease (Max Lease) – Here only the Kigali Protocol Signatory countries are considered to be contributing traffic to the network (Capacity is still being leased where available across Non signatory countries, but those Countries are not contributing traffic to the network)
    - Kigali Protocol Countries and All Build (All Build) - Here, again it is only the Kigali Protocol countries contributing traffic, but in all cases here, we are proposing to Build new infrastructure along the cheapest routes
    - All Countries and Maximized Lease (Max Lease) – Here all countries are considered to contribute traffic onto the network. Wherever capacity is available, it will be leased, and the rest will entail new Build
    - All Countries and All Build (All Build) – Here, again, all countries are considered to contribute traffic to the network, but all required capacity is to be built

1 Executive Summary

Network Design 1: Kigali Protocol Countries (12 countries, 14 country nodes), maximum lease: This design has the SPV leasing fibres on existing cables. The SPV installs and manages its own optical fibre cable where no ability to lease capacity exists.

- This option plans for a fully SPV owned and operated network, serving the 12 Kigali Protocol countries. This design has the SPV leasing fibres on existing cables. The SPV installs and manages its own optical fibre cable where no ability to lease capacity exists
- All network management centres, country nodes, repeater stations and equipment belong to the SPV.
- Cable where required is installed underground or overhead on utility structures along routes modelled to be representative.
- Redundancy and capacity are calculated and optimised according to the model.
- Capacity is phased according to its growth, Undersea capacity is used where possible.
- Connections to the rest of Africa and Europe are made via undersea cables, Only connections in Kigali Protocol countries are illustrated.
- Note that while Dar Es Salaam appears to be a single point of failure, redundancy is achieved due to the configuration of the undersea cables.

Network Design 1: Kigali Protocol Countries (12 countries, 14 country nodes), maximum lease



Costing for Network Design 1: Kigali Protocol Countries (12 countries, 14 nodes), maximum lease: As shown the impact of redundancy has a significant impact on the Full Redundancy & No Redundancy network design costing options.

Network Costing for Network Design 1 - Design Parameters:

- Maximum lease
- Countries: 12
- Country nodes: 14
- Full redundancy option shown

Network Design 1 Costing – Capex and Opex (15 year period)

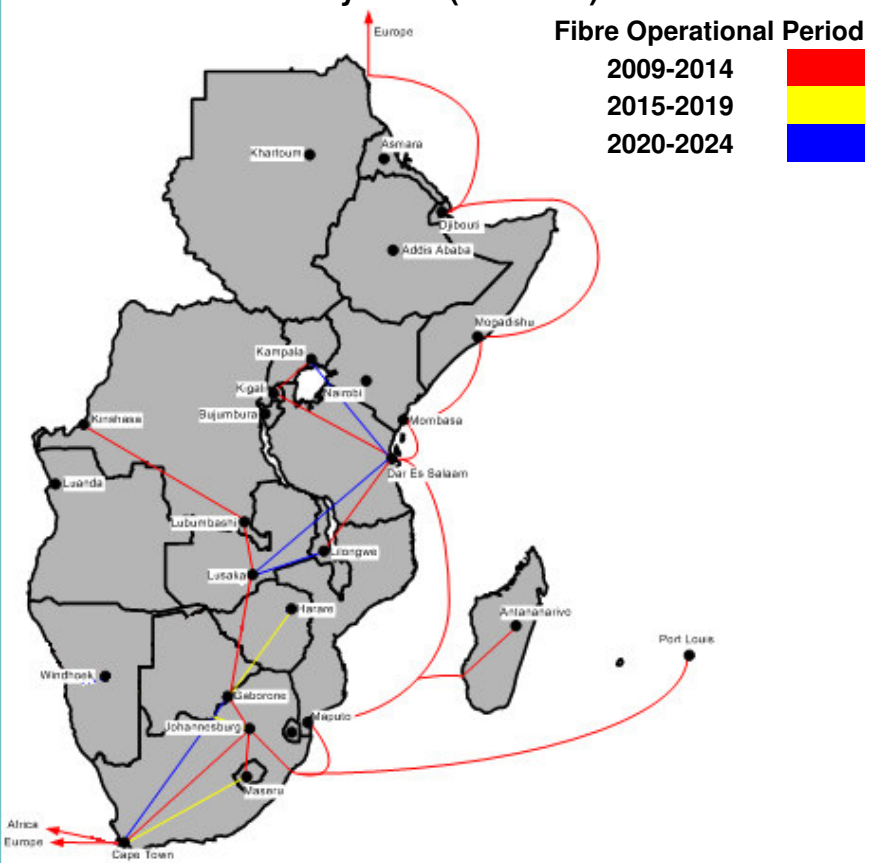
Network Option	Total Capex USD million NPV 15 years)	Total Opex USD million (NPV 15 years)	Mean Capex / km built (includes Nodes) USD thousand / km	Mean Opex / km built (includes Nodes) USD thousand / km
Full Redundancy	$ 384	$1,025	$ 38.9	$ 104

- The Kigali Protocol Max Lease case offers an alternative design option with significantly reduced Capex expenditure
- Mean Capex Cost/km is again much higher as built cable is much lower and fixed costs distort the average figure.
- The impact of redundancy on the Capex cost is again significant – 55% less for No Redundancy.
- Opex Costs (NPV) are higher for Fully Redundant Case (30%) as secondary routes are leased on Submarine cables to achieve fully independent routes

Network Design 2: Kigali Protocol Countries – Full build for all necessary links (All Build). This design sees the SPV building and operating its own network to serve the Kigali Protocol countries.

- This option plans for a fully SPV built, owned and operated network, serving the 12 Kigali Protocol countries.
- All network management centres, country nodes, repeater stations, equipment and optical fibre cable belong to the SPV.
- Cable is installed underground or overhead on utility structures along routes modelled to be representative.
- Redundancy and capacity are calculated and optimised according to the model.
- Capacity is phased according to its growth.
- Undersea capacity is used where possible.
- Connections to the rest of Africa and Europe are made via undersea cables.
- Only connections in Kigali Protocol countries are illustrated.
- Note that while Dar Es Salaam appears to be a single point of failure, redundancy is achieved due to the configuration of the undersea cables.

Network Design 2: Kigali Protocol Countries – Full build for all necessary links (All Build)



Costing for Network Design 2: Kigali Protocol Countries – Full build for all necessary links (All Build): Full Redundancy & No Redundancy

Network Costing for Network Design 2 - Design Parameters:

- Full Build
- Countries: 12
- Country Nodes: 14
- Full redundancy option shown

Network Design 2 Costing – Capex and Opex (15 year period)

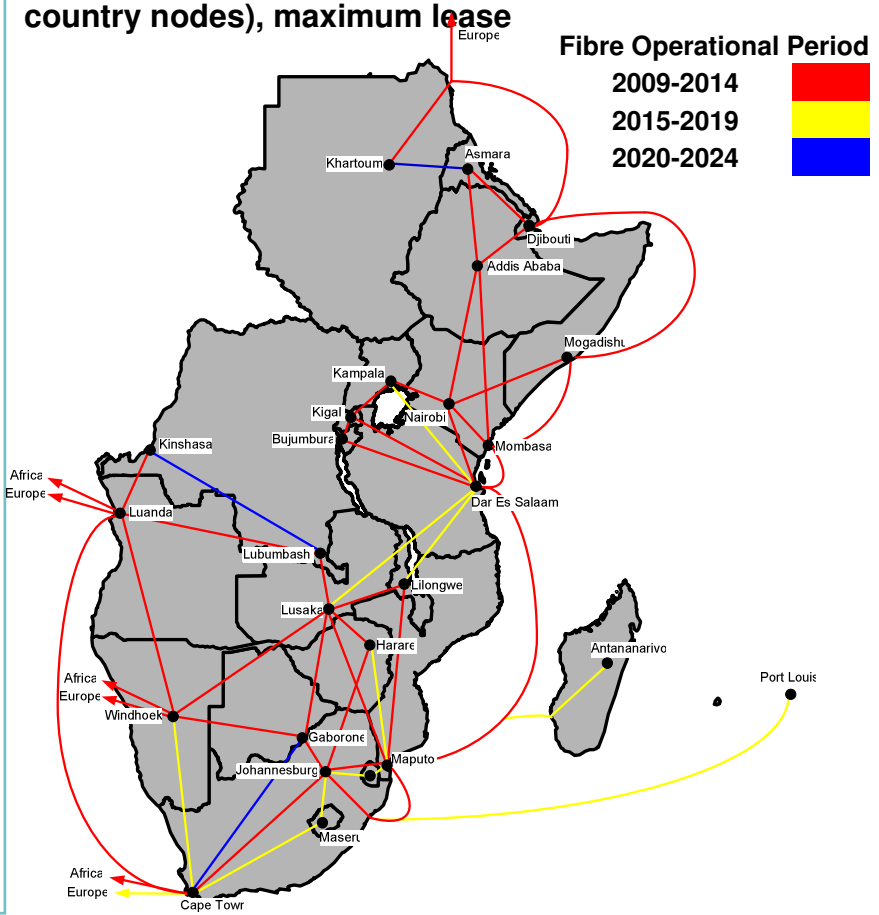
Network Option	Total Capex USD million (NPV 15 years)	Total Opex USD million (NPV 15 years)	Mean Capex / km built (includes Nodes) USD thousand / km	Mean Opex / km built (includes Nodes) USD thousand / km
Full Redundancy	$ 975	$1,023	$ 27.6	$ 30.0

- The Kigali Protocol case offers an alternative design option with significantly reduced Capex expenditure
- The impact of redundancy on the Capex cost is significant – 66% less for No Redundancy.
- Opex Costs (NPV) are higher for Fully Redundant Case (23%) as secondary routes are leased on Submarine cables to achieve fully independent routes

Network Design 3: All Countries (23 countries, 25 country nodes), maximum lease: This design has the SPV leasing dark fibres on existing cables. The SPV installs and manages its own optical fibre cable where no ability to lease capacity exists.

- This option plans for a fully SPV owned and operated network, serving all 23 countries, but where possible dark fibres are leased on existing cables. Additional optical fibre cable is installed, owned and operated by the SPV.
- All network management centres, country nodes, repeater stations and equipment belong to the SPV.
- Cable is installed underground or overhead on utility structures along routes modelled to be representative.
- Redundancy and capacity are calculated and optimised according to the model.
- Capacity is phased according to its growth.
- Undersea capacity is used where possible.
- Connections to the rest of Africa and Europe are made via undersea cables.
- Note that while Dar Es Salaam appears to be a single point of failure, redundancy is achieved due to the configuration of the undersea cables.

Network Design 3: All Countries (23 countries, 25 country nodes), maximum lease



Costing for Network Design 3: All Countries (23 countries, 25 nodes), maximum lease: Full Redundancy

Network Costing for Network Design 3 - Design Parameters:

- Maximum lease
- Countries: 23
- Country Nodes: 25
- Full redundancy option shown

Network Design 3 Costing – Capex and Opex (15 year period)

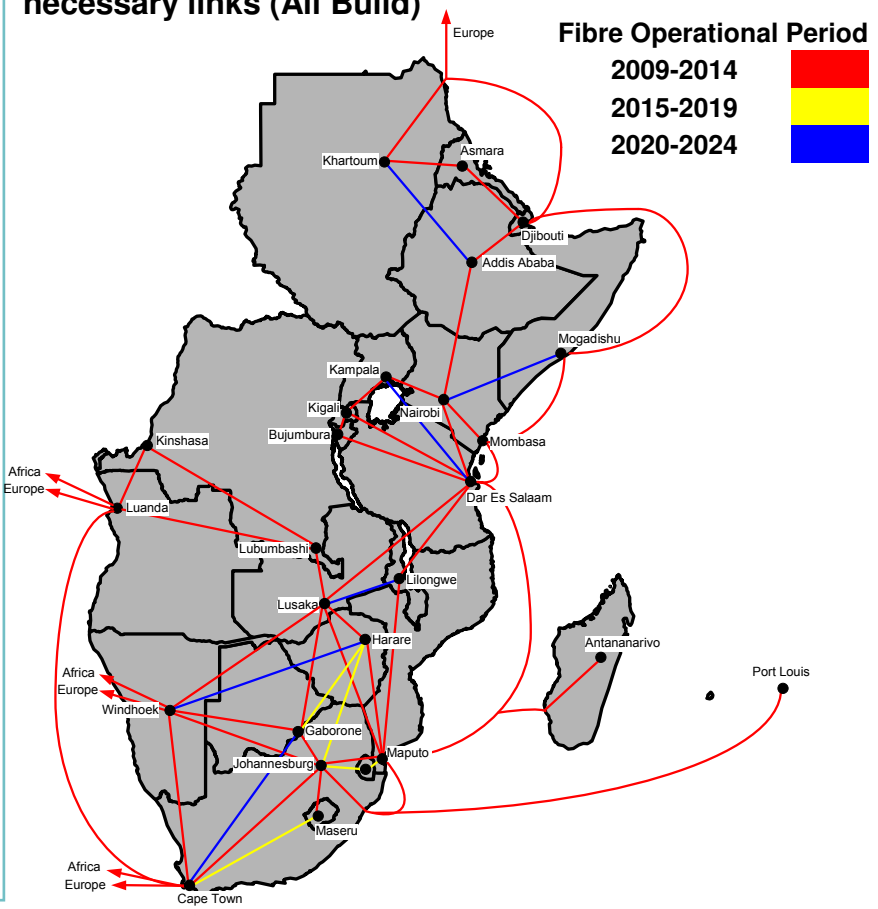
Network Option	Total Capex USD million (NPV 15 years)	Total Opex USD million (NPV 15 years)	Mean Capex / km built (includes Nodes) USD thousand / km	Mean Opex / km built (includes Nodes) USD thousand / km
Full Redundancy	$ 739	$1,947	$ 15.4	$ 40.6

- The Capex costs are substantially lower than the All-Build case. (43% less)
- Opex is spread more evenly over the 15 years as capacity is leased only on demand. Maintenance Opex is lower than for the All Build Case but Lease Opex is higher. The end result is a 7% saving over the All Build Case in NPV-stated Opex.
- This Option forms the strategically more attractive case i.e. Lease wherever possible and includes all 23 countries.

Network Design 4: All Countries – Full build for all necessary links (All Build): This design sees the SPV building and operating its own network to serve the 23 countries.

- This option plans for a fully SPV built, owned and operated network, serving all 23 countries.
- All network management centres, country nodes, repeater stations, equipment and optical fibre cable belong to the SPV.
- Cable is installed underground or overhead on utility structures along routes modelled to be representative.
- Redundancy and capacity are calculated and optimised according to the model.
- Capacity is phased according to its growth.
- Undersea capacity is used where possible.
- Connections to the rest of Africa and Europe are made via undersea cables.
- Note that while Dar Es Salaam appears to be a single point of failure, redundancy is achieved due to the configuration of the undersea cables.

Network Design 4: All Countries – Full build for all necessary links (All Build)



Costing for Network Design 4: All Countries – Full build for all necessary links (All Build):: Full Redundancy

Network Costing for Network Design 4 - Design Parameters:

- Full Build
- Countries: 23
- Nodes: 25
- Full redundancy option shown

Network Design 4 Costing – Capex and Opex (15 year period)

Network Option	Total Capex USD million (NPV 15 years)	Total Opex USD million (NPV 15 years)	Mean Capex / km built (includes Nodes) USD thousand / km	Mean Opex / km built (includes Nodes) USD thousand / km
Full Redundancy	$ 1,306	$2,083	$ 28.0	$ 44.7

- This is clearly the most expensive case in terms of Capex
- Opex over the 15 year period is also highest due to the fact that Maintenance is incurred from Yr #1 (NPV front loaded) as well as the substantial cost of redundancy in the latter years (submarine capacity lease) when traffic volumes increase rapidly
- This Option forms the Uppermost Cost Limit for this set of Designs and should be considered the Worst Case Scenario.
- The figure of $28,000 is a the Mean Capex Cost/km of rolling out this design option (and includes the cost of NMC, Nodes and repeaters)

1 Executive Summary

Network Design and Costing: The four network designs considered show that the capex required varies from USD384 million to USD 1306 million. This is calculated on a Net Present Value (NPV) over 15 years.

- Overall Capex and Opex costs are developed per model, for the networks only, considering:
  - Network and Node redundancy requirements (see the main bullet point below)
  - Equipment cost and fibre cost
  - NOC and Country Node locations
  - Excluding "business" operating costs such as marketing, accounting, human resources
- An alternative illustrative option has been proposed where Redundancy has been removed completely:
  - The Base Case requested (a Fully Redundant network) has been proposed where no intermediate link components or Nodes between the end points are shared. This has been done including both 1+1 (where the total link traffic is < STM4) and 1+4 (where the link traffic is >= STM4) redundancy.
  - An alternative Case has been included for illustration where Redundancy has been removed completely.

1 Executive Summary

Network Design and Costing: The four network designs considered show that the capex required varies from USD384 million to USD 1306 million. This is calculated on a Net Present Value (NPV) over 15 years.

Network Design Option	Total Capex (NPV over 15 yrs) USD million	Total Opex (NPV over 15yrs) USD million
Network Design 1: Kigali Protocol Countries (12 countries, 14 nodes), maximum lease (Fully Redundant)	**$ 384**	**$ 1,025**
Network Design 2: Kigali Protocol Countries – Full build for all necessary links (All Build) (Fully Redundant)	**$ 975**	**$ 1,023**
Network Design 3: All Countries (23 countries, 25 nodes), maximum lease (Fully Redundant)	**$ 739**	**$ 1,947**
Network Design 4: All Countries – Full build for all necessary links (All Build) (Fully Redundant)	**$ 1,306**	**$ 2,083**

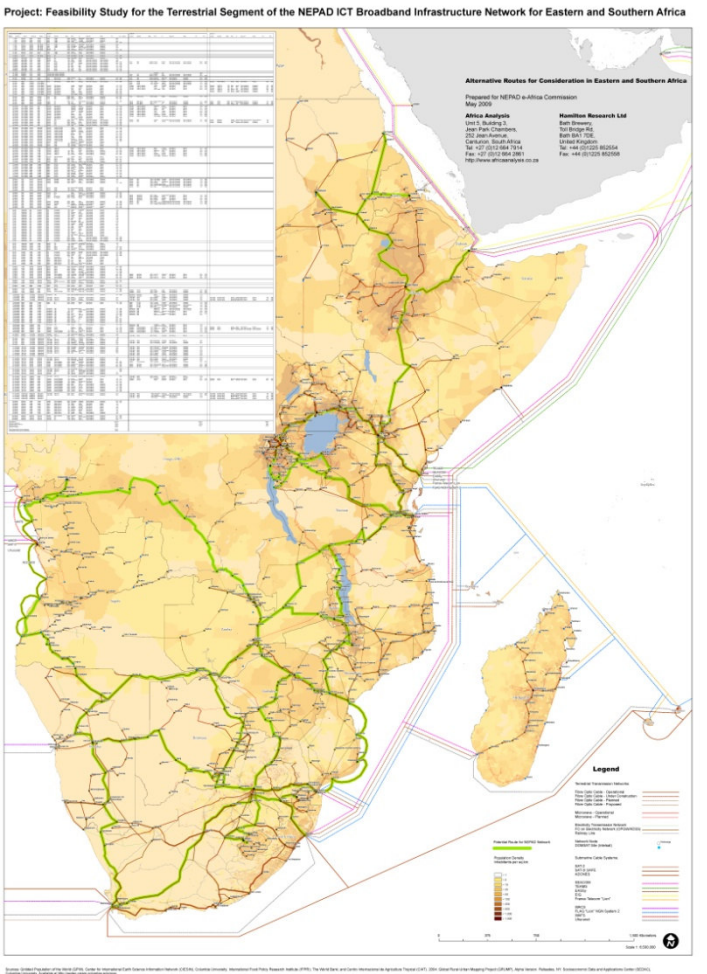
1 Executive Summary

Maximum Lease for 23 Countries Network Design: A total of 29,135km of optical fibre is required for the proposed network. Of this, 60% of the required optical fibre is already operational while another 8% is under construction.

- This map shows the max lease option for the 23 countries.
- The status of the required terrestrial optical fibre (OF) is as follows:

Status	Length (km)	%
OF Operational :	17,372	60%
OF Under construction	2,276	8%
OF Planned	6,600	23%
OF Proposed	2,887	9%
Total Required	**29,135**	**100%**

- Along 51% of the required route , the SPV would be able to lease optical fibre from two competitor networks .
- Along 10% of the required route , the SPV would be able to lease optical fibre from three competitor networks .



1 Executive Summary

Recommendations: The four network designs would need to be reviewed against the profitability of the various links (based on the potential revenue earned per link) to ensure that the optimised designs are developed.

Key recommendations for this project

- Each network design and resultant costing needs to be optimised based on a selected scenario, where exogenous drivers are agreed upon by potential financiers.
- Rollout and implementation strategy key components:
  - Only country nodes to be rolled out in first year with all interlinking capacity leased
  - Only introduce redundancy in those links and nodes which are critical
  - Only build own links in subsequent years where there is no capacity available, and when there is the requirement for such capacity
  - Only offer links where traffic is greater than an equivalent STM1 (Utilise stand alone alternatives such as Very Small Aperture Terminal – VSAT for all other cases & charge for them separately – Not part of the combined network offering)
  - Only follow the option to Lease as much as possible, and only build where necessary

Future studies and requirements going forward

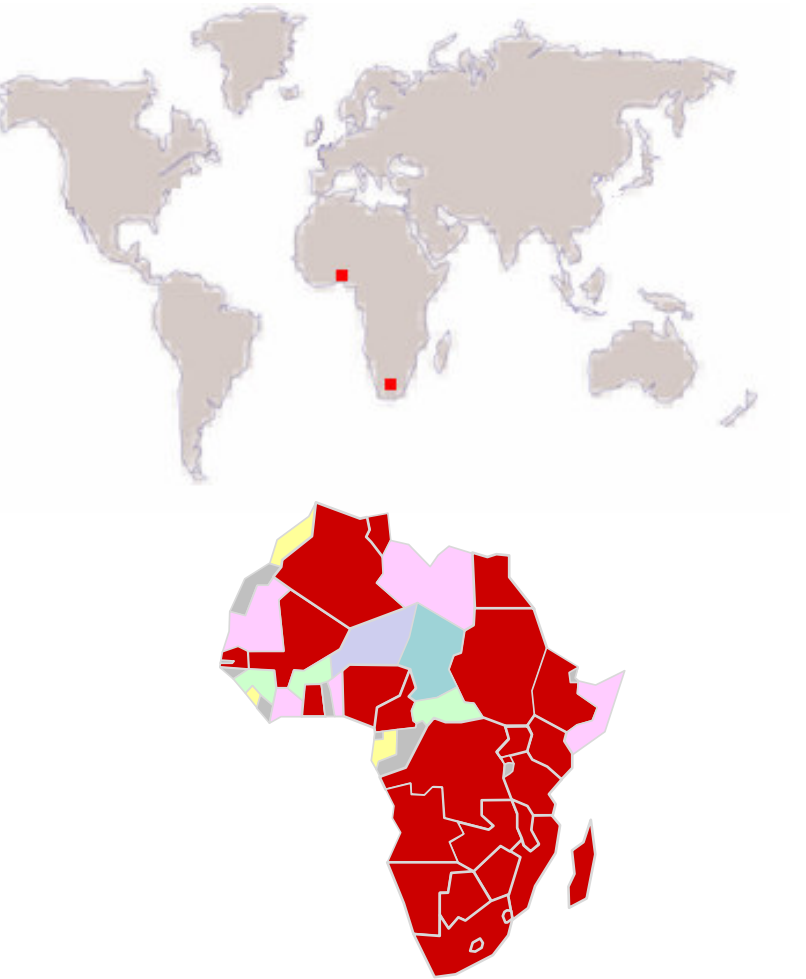
- Routes need to be prioritised based on the economic benefits of their inclusion, and this used to drive rollout
- Evaluation of redundancy requirements on major links, and the selection of redundancy levels per link according to design philosophy
- Expansion of the current Network Model into a full Business Plan incorporating a full set of Financials for the 15 years under consideration, and including key Financing options for the SPV
- Creation of a full Network Development Plan including a full network strategy, and incorporating the above outputs.

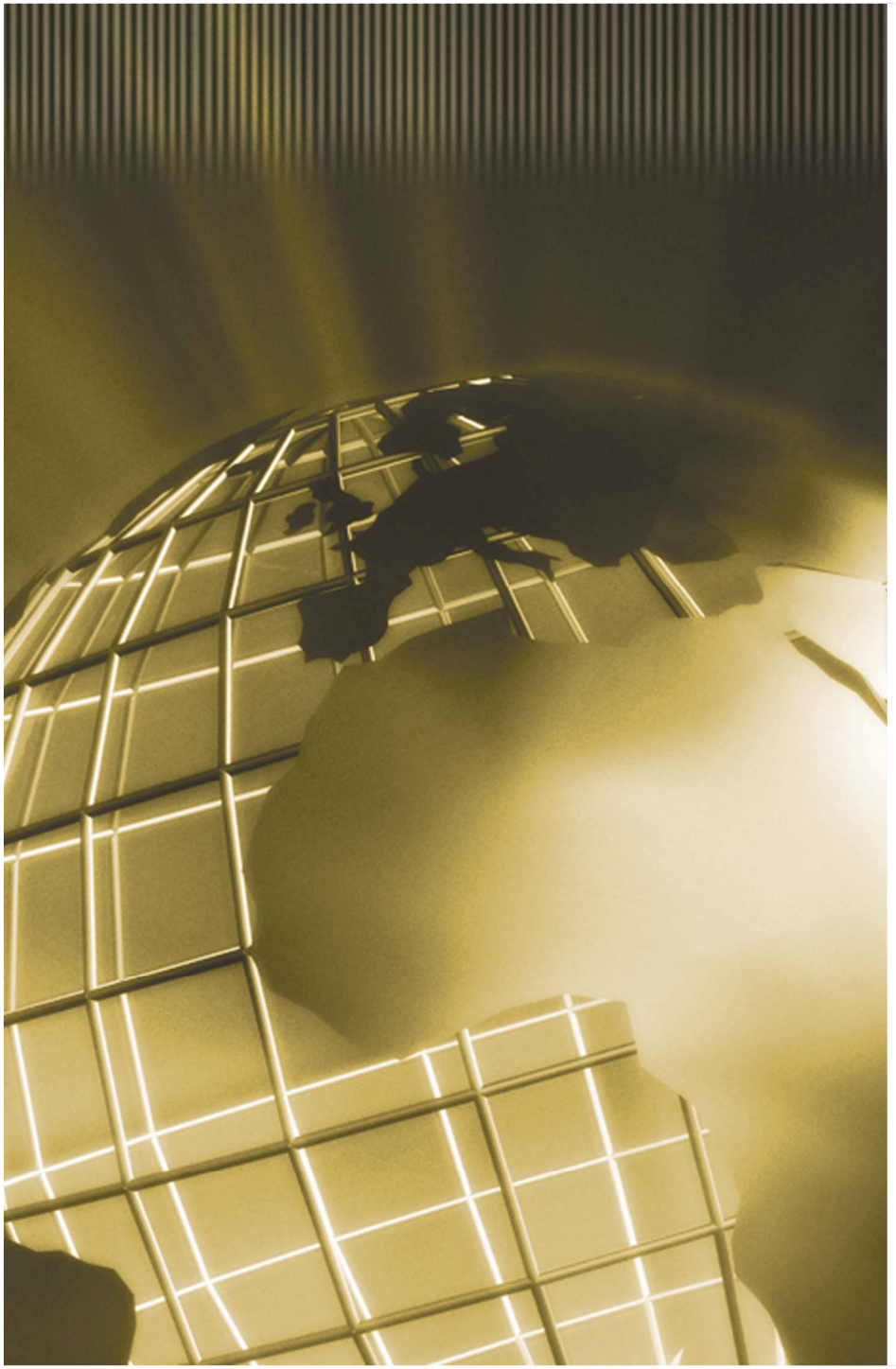
9 About Africa Analysis

Who we are: Work exclusively in the ICT markets in developing markets. Offices are located in Nigeria and South Africa.

Telecoms	IT	Media

- Established in 2002
- Offices in South Africa and Nigeria
- Africa Analysis (www.africaanalysis.co.za) provides specialist consulting and analysis services in the telecommunications, IT and media sectors.
- We differentiate ourselves through our deep focus and understanding of ICT markets in developing countries.
- We have undertaken projects in 54 African countries and have travelled on projects to most African countries.





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Contact Details

Africa Analysis Team

Andre Wills

+27 (0)12 664 7914

andre@africaanalysis.co.za

www.africaanalysis.co.za